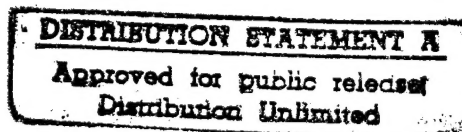


DoD Guide to Integrated Product and Process Development

(Version 1.0)

February 5, 1996



19960315 052

**OFFICE OF THE UNDER SECRETARY OF DEFENSE
(ACQUISITION AND TECHNOLOGY)
WASHINGTON, DC 20301-3000**

DTIC QUALITY INSPECTED 1

AD NUMBER	DATE	DTIC ACCESSION NOTICE
1. REPORT IDENTIFYING INFORMATION		REQUESTED.
A. ORIGINATING AGENCY Director, Test, Systems Engineering & Evaluation, OUSD(A&T)		1. Pul on.
B. REPORT TITLE AND/OR NUMBER DoD Guide to Integrated Product & Process Development(V1.0)		2. Con
C. MONITOR REPORT NUMBER N/A		3. Attame
D. PREPARED UNDER CONTRACT NUMBER MDA970-89-C-0019		4. Use int
2. DISTRIBUTION STATEMENT Distribution Statement A; Approved for Public Release; Distribution is Unlimited.		5. Do for
		DTIC
		1. As
		2. Re

19960315 052

DTIC Form 50
OCT 95

PREVIOUS EDITIONS ARE OBSOLETE

DoD Guide to Integrated Product and Process Development (Version 1.0)

February 5, 1996



**OFFICE OF THE UNDER SECRETARY OF DEFENSE
(ACQUISITION AND TECHNOLOGY)
WASHINGTON, DC 20301-3000**



ACQUISITION AND
TECHNOLOGY

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000



05 FEB 1996

FOREWORD

Reform of the acquisition process is now a driving force in the Department of Defense. A number of specific acquisition reform initiatives have been conceived, some borrowed from industry, and briefed at the highest levels of Government. Many have been mandated by the Secretary of Defense, Dr. William Perry, implemented by the Under Secretary of Defense for Acquisition and Technology, Dr. Paul Kaminski, the Services, and some have been enacted by Congress. One such initiative borrowed from industry that will fundamentally change the way the Department does business is Integrated Product and Process Development (IPPD).

IPPD is a widely defined management technique normally implemented by Integrated Product Teams (IPTs). IPPD is currently in growing use in many commercial and government organizations. This guide has been written to serve as a primer for the Defense Acquisition Workforce to foster, facilitate and understand the use of IPPD. It's focus is how industry implements IPPD and how this impacts the DoD's role in the acquisition process and the program office interfaces with their industrial counterparts. It is a non-directive "living document" that contains industry and government best practices acquired from a survey regarding IPPD implementation.

This guide is being developed in concert with the revised versions of DoD Directive 5000.1 and DoD Instruction 5000.2 and with "The Rules of the Road — A Guide for Leading Successful Integrated Product Teams." Through periodic updates, it will be kept consistent with the acquisition direction given in DoDI 5000.2 and OSD guidance publications, as well as other current approved acquisition practices. This guide will also be included in the forthcoming DoD Acquisition Deskbook.

Follow-on efforts will include a closer look at the use of tools, teams, and processes to be included in future editions and an accompanying IPPD Handbook. This handbook will present IPPD management practices in greater depth citing appropriate lessons learned and case studies.

Suggestions for improving the guide or potential case studies for the handbook are welcomed. Members of the defense acquisition community are encouraged to submit inputs. Comments and recommendations for improvement to the guide can be forwarded to: OUSD(A&T)/DTSE&E; ATTN: Mr. Mark D. Schaeffer, Deputy Director, Systems Engineering; 3110 Defense Pentagon; Washington, DC 20301-3110. Telephone: Commercial: (703) 697-6329 or DSN 225-2300. E-mail: mschaeff@acq.osd.mil.


John A. Burt
Director, TSE&E



Table of Contents

Foreword	iii
Table of Contents	v
List of Figures	vii
Executive Summary	ix
DoD Guide to Integrated Product and Process Development	
Chapter 1 IPPD Concept	
Introduction	1-1
Background	1-2
IPPD Concept.....	1-3
IPPD Key Tenets.....	1-5
Integrated Product Teams (IPT).....	1-7
A Typical Industry Approach.....	1-8
Expected Benefits of IPPD.....	1-9
Chapter 2 IPPD and DoD Acquisition	
Background	2-1
Acquisition Process.....	2-1
Variations of the Acquisition Process	2-3
OSD IPT Implementation	2-4
IPPD Tools.....	2-4
Development Processes.....	2-8
Education and Training	2-9
Barriers to Implementation	2-10
Chapter 3 Management of IPPD in DoD Acquisitions	
Background	3-1
DoD's Role.....	3-1
Industry-DoD Team Relationship	3-4
Appendix 1 - Acronyms	

List of Figures

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1-1	A Generic IPPD Iterative Process	1-3
1-2	Generic IPTs Implementation Process (Industry)	1-8
1-3	Traditional Serial Approach Versus IPPD	1-10
2-1	IPT Types, Focus and Responsibilities	2-4
3-1	Notional IPT Structure	3-2

Executive Summary

The ultimate goal of DoD acquisition is to provide the warfighters with world-class equipments and systems at an affordable cost and on a schedule that is responsive to the need. Accordingly, the Secretary of Defense, William J. Perry directed on May 10, 1995, the "immediate implementation" of a management process called Integrated Product and Process Development (IPPD) throughout the acquisition process to the maximum extent practicable. To expand upon the Secretary's memorandum and to outline an application of the IPPD process to the Acquisition System, this guide has been prepared to assist the acquisition work force and the defense industry. It is **non-directive** and serves as only one tool in understanding this time-tested, proven, yet evolving process.

At the core of IPPD implementation are Integrated Product Teams (IPTs) that organize for and accomplish, tasks that acquire goods and services. These multifunctional teams are the foundation of the process. The IPT decision-making processes and the empowerment of the teams may require cultural change in the way decisions are made in the Department. Results of a recent DoD survey show that where an IPPD process has been effectively implemented, the acquisition timeline has been shortened, and life-cycle costs have been reduced, while continuing to meet the warfighter's needs.

This document is designed to provide a general understanding of the Department's perspective on IPPD. It is intended to build upon the IPPD efforts underway within industry and government. DoD Components are encouraged to use this guide in the education of their acquisition work force and to tailor its contents as applicable to their particular acquisition programs.

The contents of this guide are organized into three chapters. Chapter 1 is a discussion of generic IPPD and IPT concepts, characteristics, and benefits normally found in industry. Chapter 2 outlines tools, techniques, and processes used in DoD and includes a list of barriers that organizations have encountered. Chapter 3 addresses the management of IPPD involving both DoD and supporting industry. This guide borrows heavily from many industry and government sources. Additionally, this guide incorporates suggestions from a recent DoD survey of government and industry that sought lessons learned and information on IPPD experiences.

OSD implementation of IPTs and guidance regarding their formation and use is contained in the DoD "Rules of the Road - A Guide for Leading Successful Integrated Product Teams" (November 95)

It is the intent to continuously augment, update, and increase the utility of this guide. As such, suggestions for its improvement are welcome.

Chapter 1 IPPD Concept

Introduction

“...I am directing a fundamental change in the way the Department acquires goods and services. The concepts of IPPD and IPTs shall be applied throughout the acquisition process to the maximum extent practicable.”

from SECDEF Memo of 10 May 1995

The Department of Defense (DoD) has worked to find the best methods for reengineering its processes. Several studies have addressed the benefits of using Integrated Product and Process Development (IPPD). IPPD has been successfully used by the private sector and by the Services on selected programs to reduce product cost and to field products sooner.

In “Acquisition Reform: A Mandate for Change,” the Secretary of Defense concluded,

“(DoD) must reduce the cost of the acquisition Process by the elimination of activities that, although being performed by many dedicated and hard-working personnel, are not necessary or cost effective in today’s environment.”

DoD must shift from an environment of regulation and enforcement to one of incentivized performance. The objective is to be receptive to ideas from the field to obtain buy-in and lasting change.

IPPD has been mandated for the Department of Defense. IPPD is a management technique that simultaneously integrates all essential acquisition activities through the use of multidisciplinary teams to optimize the design, manufacturing, business, and supportability processes.

At the core of IPPD implementation are Integrated Product Teams (IPTs) that organize for and accomplish tasks that acquire goods and services. These multifunctional teams are the foundation of the process. The IPT decision-making processes and the empowerment of the teams may require cultural change in the way decisions are made in the Department. The Under Secretary of Defense (Acquisition & Technology) has recently identified critical changes that must take place in DoD in order for successful IPTs to be formed. He indicated that DoD must move away from a pattern of hierarchical decision making to a process where decisions are facilitated across organizational structures by IPTs.

“It means breaking down institutional barriers. It also means that our senior management staffs are in a receive mode - not just a transmit mode.”

This guide is a primer on IPPD. Nothing in this guide should be construed as directive in nature. Any processes described are examples. Those processes actually used should be decided upon at the appropriate time by the implementing organization and tailored for each application.

Background

IPPD has its roots in integrated design and production practices, concurrent engineering, and total quality management. In the early 1980s, U.S. industry used the concept of integrated design as a way to improve global competitiveness.

Industry's implementation of IPPD expanded concurrent engineering concepts to include all disciplines, not just technical, associated with the design, development, manufacture, distribution, support, and management of products and services. Diverse segments of U.S. industry have successfully implemented this concept to become recognized leaders in IPPD practices, most notably in the auto and electronics industry. Many corporations have institutionalized the IPPD process and associated training programs. Several of these corporations were consulted in the development of this guide.

Several government actions led to the Department of Defense (DoD) formally adopting IPPD principles. These include:

The Federal Acquisition Streamlining Act of 1994

Among other things, this legislation simplified acquisition of commercial items and allowed DoD to explore innovative acquisition procedures under DoD's statutory pilot program authority.

Reengineering the Acquisition Oversight and Review Process

The Secretary of Defense chartered this effort to provide a road map of the needed changes in the oversight and review process while maintaining the DoD acquisition system's guiding principles of meeting the warfighter's needs.

Defense Manufacturing Council Review of Office of the Secretary of Defense (OSD)/Service Oversight

The report of this work proposed paradigm changes in OSD/Service oversight by shifting from regulation and enforcement to incentives; from functional isolation to integrated team action; from performance focus to looking at cost as an independent variable; from classic acquisition to a tailored, innovative approach; and from end-item focus to emphasis on the total system to include life-cycle products and processes.

Defense Science Board Report on Engineering in the Manufacturing Process (March 1993)

This task force study recommended a shift from product focus to process focus with primary emphasis on value and solution rather than performance and schedule. As had been stated in previous Defense Science Board studies, superior products result when the manufacturing processes are well understood in the development phase.

These efforts encouraged the Under Secretary of Defense for Acquisition and Technology (USD(A&T)) to issue a memorandum to reengineer the DoD acquisition oversight and review

process by directing the use of multidisciplinary teams rather than the traditional functional process. In May 1995, the Secretary of Defense issued a memorandum which broadened the scope of the USD(A&T) memorandum by directing full implementation of IPPD and IPTs in the DoD acquisition process. This guide provides suggestions on the implementation of IPPD in DoD acquisition.

IPPD Concept

DoD defines IPPD as, "A management process that integrates all activities from product concept through production/field support, using a multifunctional team, to simultaneously optimize the product and its manufacturing and sustainment processes to meet cost and performance objectives." IPPD evolved from concurrent engineering, and is sometimes called integrated product development (IPD). It is a systems engineering process integrated with sound business practices and common sense decision making. Organizations may undergo profound changes in culture and processes to successfully implement IPPD.

IPPD activities focus on the customer and meeting the customer's need. In DoD, the customer is the user. Accurately understanding the various levels of users' needs and establishing realistic requirements early in the acquisition cycle is now more important than ever. Trade-off analyses are made among design, performance, production, support, cost, and operational needs to optimize the system (product or service) over its life cycle. In order to afford sufficient numbers of technologically up-to-date systems, cost is a critical component of DoD system optimization. Cost should not simply be an outcome as has often been the case in the past. Thus, cost should become an independent rather than dependent variable in meeting the user's needs.

Although there are common factors in all known successful IPPD implementations, IPPD has no single solution or implementation strategy. Its implementation is product and process dependent. A generic IPPD iterative process is shown in figure 1-1.

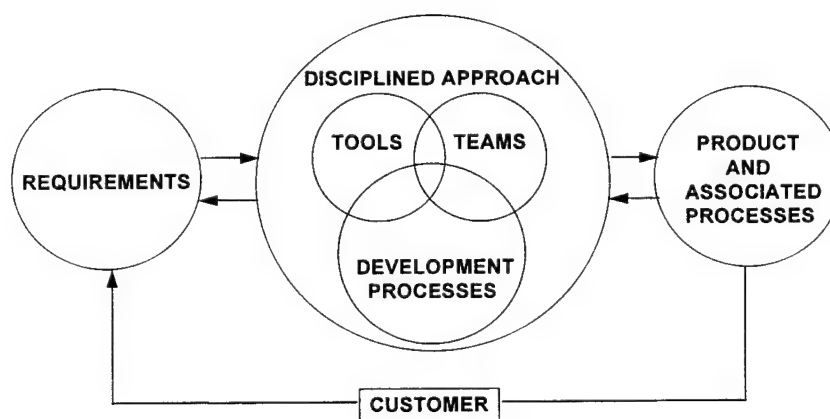


Figure 1-1. A Generic IPPD Iterative Process

Resources applied include people, processes, money, tools, and facilities. The IPPD process reorders decision making, brings downstream and global issues to bear earlier and in concert with

conceptual and detailed planning, and relies on applying functional expertise in a team-oriented manner on a global-optimization basis. It is necessary to understand early the processes needed to develop, produce, operate and support the product. Equally important are these processes' impacts on product design and development. Basic elements of the iterative process are:

Requirements, a first step in the iterative process above, are generated by the customer in a negotiation among many parties, each with serious and important concerns. Knowing and understanding the customers (command structure, doctrine, tactics, operating environment, etc.) and their needs is essential. Integrating the user's requirements, logistical requirements, and the acquirer's budgetary and scheduling constraints is a fundamental challenge in DoD acquisition.

Disciplined approach includes five general activities: understanding the requirements, outlining the approach, planning the effort, allocating resources, and executing and tracking the plan. Decisions made using this approach should be re-evaluated as a system matures and circumstances (budgetary, threat, technology) change. A disciplined approach provides a framework for utilizing tools, teams, and processes in a structured manner that is responsive to systematic improvement efforts.

Tools in this IPPD process include documents, information systems, methods, and technologies that can be fit into a generic shared framework that focuses on planning, executing and tracking. Tools help define the product(s) being developed, delivered or acted upon, and relate the elements of work to be accomplished to each other and to the end product. Examples of tools used include integrated master plans, 3-D design tools and their associated databases, cost models linked to process simulations/activity-based costing, development process control methods, and earned value management.

Teams are central to the IPPD process. Teams are made up of everyone who has a stake in the outcome or product of the team, including the customer and suppliers. Collectively, team members should represent the know-how needed and have the ability to control the resources necessary for getting the job done. Teams are organized and behave so as to seek the best value solution to a product acquisition.

Development Processes are those activities which lead to both the end product and its associated processes. To ensure efficient use of resources, it is necessary to understand what activities are necessary and how they affect the product and each other. Examples include requirements analysis, configuration management, and detailed design drawings.

Product and Associated Processes include what is produced and provided to the customer. Customer satisfaction with the product, in terms of mission effectiveness, as well as operating and support aspects and costs, is the ultimate measure of the team's success.

Customer is the user and a team member and also the ultimate authority regarding the product. Any changes to the formal requirements driving the product/process development must come through negotiation with the customer.

This generic IPPD iterative process described above is a systems engineering approach. It differs from the long held view that systems engineering is essentially a partitioning, trade-off, control process that brings the "-ilities" and test functions together. This IPPD process controls the evolution of an integrated and optimally balanced system to satisfy customer needs and to provide data and products required to support acquisition management decisions which, themselves, are part of the IPPD/IPT process. This approach also transforms the stated needs into a balanced set of product and process descriptions. These descriptions are incrementally matured during each acquisition phase and used by DoD and its contractors to plan and implement a solution to the user needs. This process balances cost, system capability, manufacturing processes, test processes, and support processes, as identified in DoD Instruction 5000.2.

The IPPD process is an integrated team effort within DoD and contractor organizations and with each other. DoD crafts the basic acquisition strategy, almost always with industry assistance. Contractors usually play a significant role in development, design, and manufacturing with DoD in a management role. Both participate in each others' major activities through team membership, and the implementation and use of tools and technology.

IPPD Key Tenets

To implement IPPD effectively, it is important to understand the interrelated tenets inherent in IPPD. These key tenets, listed below, were outlined by the Secretary of Defense mandate on IPPD and are consistent with those found in industry:

Customer Focus

The primary objective of IPPD is to identify and satisfy the customer's needs better, faster, and cheaper. The customer's needs should determine the nature of the product and its associated processes.

Concurrent Development of Products and Processes

Processes should be developed concurrently with the products they support. It is critical that the processes used to manage, develop, manufacture, verify, test, deploy, operate, support, train people, and eventually dispose of the product be considered during product design and development. Product and process design and performance should be kept in balance to achieve life-cycle cost and effectiveness objectives. Early integration of design elements can result in lower costs by requiring fewer costly changes late in the development process.

Early and Continuous Life Cycle Planning

Planning for a product and its processes should begin early in the science and technology phase (especially advanced development) and extend throughout every product's life cycle. Early life-cycle planning, which includes customers, functions, and suppliers, lays a solid foundation for the various phases of a product and its processes. Key program activities and events should be defined so that progress toward achievement of cost-effective targets can be tracked, resources can be applied, and the impact of problems, resource constraints and requirements changes can be better understood and managed.

Maximize Flexibility for Optimization and Use of Contractor Approaches

Requests for Proposals (RFPs) and contracts should provide maximum flexibility for employment of IPPD principles and use of contractor processes and commercial specifications, standards and practices. They should also accommodate changes in requirements, and incentivize contractors to challenge requirements and offer alternative solutions which provide cost-effective solutions.

Encourage Robust Design and Improved Process Capability

The use of advanced design and manufacturing techniques that promote (1) achieving quality through design, products with little sensitivity to variations in the manufacturing process (robust design), (2) a focus on process capability, and (3) continuous process improvement are encouraged. Variability reduction tools such as ultra-low variation process control similar to "Six Sigma" and lean/agile manufacturing concepts should be encouraged.

Event-Driven Scheduling

A scheduling framework should be established which relates program events to their associated accomplishments and accomplishment criteria. An event is considered complete only when the accomplishments associated with that event have reached completion as measured by the accomplishment criteria. This event-driven scheduling reduces risk by ensuring that product and process maturity are incrementally demonstrated prior to beginning follow-on activities.

Multidisciplinary Teamwork

Multidisciplinary teamwork is essential to the integrated and concurrent development of a product and its processes. The right people at the right place at the right time are required to make timely decisions. Team decisions, as a result of risk assessments, should be based on the combined input of the entire team (technical, cost, manufacturing and support functions and organizations) including customers and suppliers. Each team member needs to understand his role and support the roles of the other members, as well as understand the constraints under which team members operate. All must operate so as to seek global optima and targets.

Empowerment

Decision making should be driven to the lowest possible level commensurate with risk. Resources should be allocated to levels consistent with risk assessment authority, responsibility and the ability of people. The team should be given the authority, responsibility, and resources to manage its product and its risk commensurate with the team's capabilities. The authority of team members needs to be defined and understood by the individual team members. The team should accept responsibility and be held accountable for the results of its efforts. Management practices

within the teams and their organizations must be team-oriented rather than structurally-, functionally-, or individually-oriented.

Seamless Management Tools

A framework should be established that relates products and processes at all levels to demonstrate dependencies and interrelationships. A management system should be established that relates requirements, planning, resource allocation, execution and program tracking over the product's life cycle. This integrated or dedicated approach helps ensure teams have all available information thereby enhancing team decision making at all levels. Capabilities should be provided to share technical, industrial, and business information throughout the product development and deployment life cycle through the use of acquisition and support shared information systems and software tools (including models) for accessing, exchanging, validating, and viewing information.

Proactive Identification and Management of Risk

Critical cost, schedule and technical parameters related to system characteristics should be identified from risk analyses and user requirements. Technical and business performance measurement plans, with appropriate metrics, should be developed and compared to best-in-class government and industry benchmarks to provide continuing verification of the effectiveness and degree of anticipated and actual achievement of technical and business parameters.

Integrated Product Teams (IPT)

Integrated Product Teams are cross-functional teams that are formed for the specific purpose of delivering a product for an external or internal customer. IPT members should have complementary skills and be committed to a common purpose, performance objectives, and approach for which they hold themselves mutually accountable. IPTs are the means through which IPPD is implemented. Members of an integrated product team represent technical, manufacturing, business, and support functions and organizations which are critical to developing, procuring and supporting the product. Having these functions represented concurrently permits teams to consider more and broader alternatives quickly, and in a broader context, enables faster and better decisions. Once on a team, the role of an IPT member changes from that of a member of a particular functional organization, who focuses on a given discipline, to that of a team member, who focuses on a product and its associated processes. Each individual should offer his/her expertise to the team as well as understand and respect the expertise available from other members of the team. Team members work together to achieve the team's objectives.

Critical to the formation of a successful IPT are: (1) all functional disciplines influencing the product throughout its lifetime should be represented on the team; (2) a clear understanding of the team's goals, responsibilities, and authority should be established among the business unit manager, program and functional managers, as well as the IPT; and (3) identification of resource requirements such as staffing, funding, and facilities. The above can be defined in a team charter which provides guidance.

A Typical Industry Approach

Each step identified in figure 1-2 is important in establishing IPTs to implement IPPD. It is representative of an implementation process found in industry. These steps should be tailored in scope depending upon the size of the program and type of IPT.

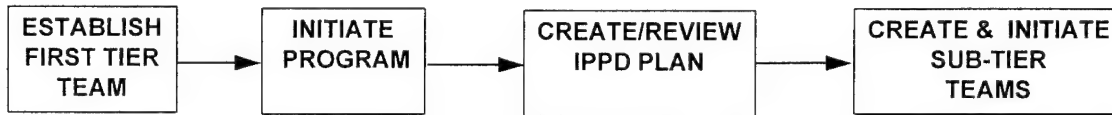


Figure 1-2. Generic IPTs Implementation Process (Industry)

The intent of this sequence of steps is to insure that the team's mission, objectives, and end products are well defined, and that each team member's role and responsibility are clearly stated.

Establish First Tier Integrated Product Team - The selection of a first tier team, which provides strategic direction and corporate oversight, and review, is an important aspect of the process. Appropriate cross-functional team composition will optimize the chances for success.

Initiate the Program - The first tier team identifies/validates a need and organizes for program management by initiating a program.

Create/Review IPPD Plan - An IPPD Plan (a document containing an Integrated Master Plan, Integrated Master Schedule, and a Project Budget Baseline) should define the scope of the anticipated effort and role of the first tier IPT, and the inter-dependencies and expectations between the first tier and sub-tier teams.

Create and Initiate Sub-tier Teams - Once the first tier team has created an initial plan, the sub-tier teams are established. These sub-tier teams should also be multidisciplinary rather than functionally oriented and have specific charters that identify expectations and responsibilities in providing program support. Sub-tier team leaders should be members of the next higher tier team.

This approach to teaming differs from traditional program organizations, which usually focus on single-function disciplines. IPTs are responsible not only for designing the product and its associated processes, but also for planning, tracking, and managing their own work and the processes by which they do their work. Successful application of IPPD rests heavily on the ability to form, align, empower, and lead these cross-functional teams. By transitioning from the traditional use of mandated decisions to a style of leadership that operates through coaching and empowering, an open environment of rapid and honest communication and effective, timely decision making required by IPPD can be created.

The concepts of effective team formation apply to all types of teams. IPTs can be applied at various levels ranging from the overall structure of an organization to informal groups functioning across existing units. IPTs can be formally chartered or natural working groups. Implementation of IPPD, therefore, does not mean that an organization needs to restructure. However, virtually all successful, sustained implementations in industry have eventually entailed reorganizations or re-missioning of organizations or both. These reorganizations are generally undertaken after IPPD implementation has been initiated and experience has indicated a need to realign functions. The team is not the end goal of IPPD, but rather the means through which much of the work is accomplished. The teams are created for the specific purpose of delivering a product and its processes or managing a process for their customer(s).

An IPT structure can be optimized for the product/customer requirements. The number of teams, functional disciplines, and full/part-time members required to support the product development may be different for every program. In addition, team membership, including team leadership, may change throughout the product development cycle. The core members of the team, generally assigned full-time, provide continuity from one development phase to another.

Teams focus on achieving set goals and objectives. Metrics are a means for creating and maintaining that focus. When metrics provide meaningful data, IPTs can clearly see and understand their progress, and better allocate resources for the remaining tasks. Identification and management of risk are key responsibilities of each IPT.

Expected Benefits of IPPD

Applying the IPPD management philosophy can result in significant benefits to the customer, DoD, and industry. The primary benefits are reduced cost and schedule while maintaining, often increasing, quality. Essentially, a more balanced tradeoff is achieved among cost, schedule and performance. These gains are realized by the early integration of business, contracting, manufacturing, test, training, and support considerations in the design process, resulting in fewer costly changes made later in the process (e.g., during full rate production or operational test). Figure 1-3 displays anticipated design changes resulting from IPPD implementation versus traditional (serial) acquisition approach, overlaid on a curve of relative cost of making changes. In a traditional approach, the largest number of changes occur late in development, when change costs are high, resulting in higher program costs. In an IPPD process, the bulk of changes occur early in development, when change costs are low, resulting in lower program costs.

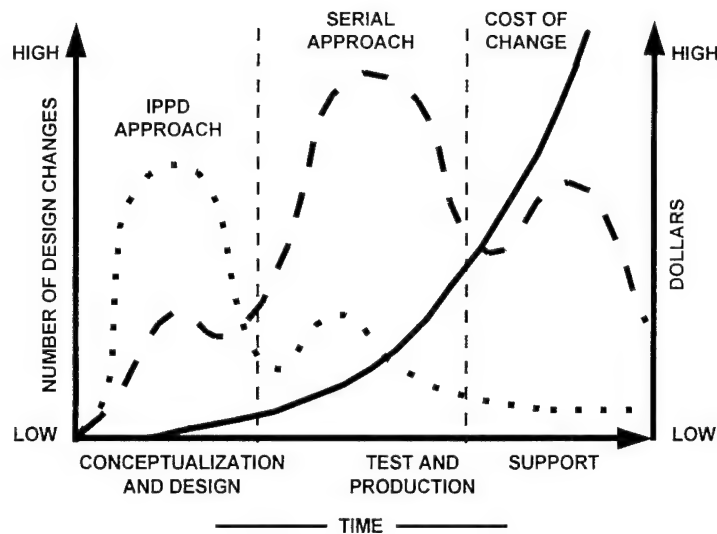


Figure 1-3. Traditional Serial Approach Versus IPPD

The traditional acquisition approach involved each specialist group completing its work in isolation and then passing results on to the next specialist group. This serial approach has resulted in stovepipe competition for organizational rewards. It establishes walls between organizations with resulting inefficiency and ineffectiveness, including a lack of networking and inter-functional communication.

Use of IPPD and IPTs is the antithesis of the traditional approach. The central notion is that product quality and user satisfaction can best be achieved by the integrated concurrent design of the product and its processes. For example, in IPPD future process requirements are identified and integrated into the evolving product design while still very early in the design phase. However, IPPD does not stop with a one-time identification of process requirements. As product design matures, continued emphasis is placed on the processes, and their attendant costs, required to manufacture, operate, and support the product. This approach greatly reduces the risk associated with design and development. Product and process maturity are achieved earlier, obviating some of the costly late redesign efforts that characterize traditional developments. Moreover, the up-front trade-offs result in more cost-effective designs. Designs can be optimized for cost effectiveness based not exclusively on acquisition cost, but on overall life cycle cost. Such considerations can be critical, since operations and support costs may far exceed acquisition cost.

Successful IPPD implementation can result in:

Reduced overall time to deliver an operational product. Decisions that were formerly made sequentially are now made concurrently and from an integrated perspective. These decisions are based on a life cycle perspective and should minimize the number and magnitude of changes during manufacturing and eventual operational deployment of the product. This in turn reduces late, expensive, test-fix and test-redesign remanufacture cycles that are prime contributors to schedule extensions and overruns.

Reduced system (product) cost. Increased emphasis on IPPD at the beginning of the development process impacts the product/process funding profile (as shown in figure 1-3).

Specifically, funding profiles based on historical data may not be appropriate. Some additional funds may be required in the early phases, but the unit costs as well as total life cycle costs should be reduced. This will be primarily due to reduced design or engineering changes, reduced time to deliver the system, and the use of trade-off analyses to define cost-effective solutions.

Reduced risk. Up-front team planning and understanding of technologies and product processes permits better understanding of risk and how it impacts cost, schedule, and performance. This understanding can result in methods or processes for reducing or mitigating assumed risks and establishing realistic cost, performance and schedule objectives.

Improved quality. Teamwork coupled with a desire for continuous improvement results in improved quality of the processes and a quality product for the user.

References:

Acquisition Reform Process Action Team. "Reengineering the Acquisition Oversight and Review Process." Vol I. 9 December 1994.

American Samurai Institute. Total Quality Management for Tough Times, Basic Concepts to Total Transformation. Guasti, CA.

Defense Science Board Task Force. "Engineering in the Manufacturing Process." March 1993.

United States House of Representatives Conference Report 103-712, "Federal Acquisition Streamlining Act of 1994." 21 August 1994.

GM Hughes Electronics. "Best Practices Examples: Cost Competitiveness." November 1993.

Hammer, Michael, and James Champy. Reengineering the Corporation. Harper Collins Publishers, 1993.

Hughes Aircraft Company. "Hughes Guide to Integrated Product Development." July 1994.

Secretary of Defense. Memorandum. 10 May 1995.

Under Secretary of Defense for Acquisition and Technology. Memorandum. 28 April 1995.

Other Recommended Reading:

Katzenbach, Jon R.. The Wisdom of Teams, Creating the High-Performance Organization. Boston: Harvard Business School Press, 1993.

Meyer, Christopher. Fast Cycle Time. New York: The Free Press, Macmillan, Inc., 1993.

Scholtes, Peter R.. The Team Handbook, How to Use Teams to Improve Quality. Joiner Associates Publishers, March 1991.

Zangwill, W.I.. Lightning Strategies for Innovation: How the World's Best Firms Create New Products. New York: Lexington Books, 1993.

"A Smarter Way to Manufacture." Business Week. 30 Apr. 1990:110-117.

"777 Revolutionizes Boeing Aircraft Development Process." Aviation Week & Space Technology. 30 Jun. 1991:34-36.

Chapter 2 IPPD and DoD Acquisition

“Reengineering our oversight and review process and practices is one of the most difficult issues we will face in acquisition reform. It means we will have to create a climate of reasoned, well-informed risk-management by our PMs and PEOs. Your leadership and good judgement will be critical to successful implementation of this reform. I encourage you and your leadership teams to be active participants in establishing the environment essential for implementing this change.”

Paul G. Kaminski, 28 April 1995

Background

The Department of Defense is undergoing a fundamental change in its acquisition of goods and services. Recent acquisition reform actions and new legislation, policies and procedures, along with the IPPD/IPT mandate, will be included in an update/rewrite of the DoD 5000 series of publications. Implementation and management of IPPD and IPTs are addressed in those updates. In addition, a *Defense Acquisition Deskbook* is being developed that will contain information on IPPD management and the roles and responsibilities of IPTs. This guide will be included in the deskbook and updated as necessary to reflect the latest available information to assist in implementation.

Acquisition Process

The following discussion describes the milestones and phases identified in DoDI 5000.2. This particular structure for the acquisition process has proven successful in a majority of programs. However, adherence to this process is not mandatory. Tailoring of this process to eliminate unnecessary elements is encouraged where there is clear cost or schedule benefit without unacceptable technical risk.

Tailoring may be especially appropriate when the solution to the mission need is (1) a modification to an existing military system, (2) an existing commercial item that can be used as is or adapted by modification to military use, or (3) a one-of-a-kind system. Whether or not the system follows the entire acquisition process, or is tailored, adoption of IPPD principles should be strived for, to the maximum extent practicable, to improve program performance.

The DoD acquisition process is set in motion by the validation of a mission need. Mission needs result from a continuous assessment of current and projected capability. In the case of Acquisition Category (ACAT) I programs, the Joint Requirements Oversight Council (JROC) validates the need. If a materiel solution is required, alternatives are recommended to the Milestone Decision Authority (MDA) to be considered at Milestone 0 (Approval to Conduct

Concepts Studies). USD(A&T), as the MDA, may authorize one or more concept studies to determine which alternatives best satisfy the need.

Following Milestone 0, the MDA will normally delineate exit criteria to be satisfied during Phase 0 (Concept Exploration). This phase explores selected alternatives. After exploring and reviewing the alternatives and having met exit criteria, the most promising system concepts are defined in terms of initial broad objectives for cost, schedule, and performance for the MDA. A favorable decision at Milestone I (Approval to Begin a New Acquisition Program) establishes a new acquisition program and an acquisition program baseline.

Following Milestone I, the program enters Phase I (Program Definition and Risk Reduction) as a new program start. This phase ensures that the appropriate product and process technologies have been researched, tested, and validated. Associated risks are identified, analyzed and minimized as much as possible. There must be some assurance that technologies will be available for production and use within cost targets and at an appropriate time. Assurance here varies inversely with the length of time in the projection. IPPD, therefore, has the potential of changing the technological profile for new weapons systems. Such a change would be required in any case in order to shorten schedules. This, in turn, implies a different relationship between acquisitions and the science and technology programs, described further in Variations of the Acquisition Process below. At the end of Phase I, the program should be able to establish firm cost, schedule, and performance thresholds/objectives. An integrated master plan and other documentation may be presented to the MDA. Satisfaction of Phase I exit criteria is verified at Milestone II (Approval to Enter Engineering and Manufacturing Development).

Following Milestone II, the program enters Phase II (Engineering and Manufacturing Development). In Phase II, the most promising design is developed into a system design to include manufacturing and support process development, manufacturing and support process validation, and system capability assessment through test and evaluation. Program IPTs use information available during this phase to reassess projected cost, schedule, and performance goals. As with the previous phase, satisfaction of established exit criteria is verified at Milestone III (Production or Deployment Approval).

Following Milestone III, Phase III (Production, Deployment and Operational Support) is entered. Phase III objectives include: establishing a stable efficient support base, and an operational capability that satisfies the need, confirming performance and quality, and verifying corrections of deficiencies. Once a contractor has demonstrated a system of stable compliant processes leading to cost and technical performance as contracted, the Government shall rely almost exclusively on contractor self-governance rather than Government inspectors, auditors, and compliance monitors to ensure that these processes continue to result in a system producing goods and services which meet customer needs. The Program Office supports system deployment to the field by assessing system performance, implementing support plans, and identifying deficiencies requiring correction.

This acquisition process outlined above allows for and encourages program specific tailoring. The concepts of IPPD/IPT are consistent with this process and are equally applicable to new and existing programs.

Variations of the Acquisition Process

There are variations of the acquisition process described above. These variations can result from pre-acquisition activities and/or a reduction in the scope of remaining development. Each of these alternatives will enter the DoD acquisition process at an appropriate point based on the maturity of the product. Although there are variations in the acquisition process, the need to employ an IPPD approach still applies. IPPD continues to ensure that all of the necessary activities that optimize life cycle performance and suitability are considered as early as possible.

Pre-Acquisition Activities

Two types of activities the Department is using to develop, demonstrate, and evaluate emerging technologies are Advanced Technology Demonstrations (ATDs) and Advanced Concept Technology Demonstrations (ACTDs). These activities precede the formal acquisition process.

ATDs are typically integrated demonstrations that are conducted to demonstrate the feasibility and maturity of an emerging technology. They provide a relatively low-cost approach for assessment of technical risks and uncertainties associated with critical technologies prior to the incorporation of these technologies into a system entering the formal acquisition process. If successful, the ATD can lead to an acquisition program or be integrated into a larger acquisition program. IPPDs should be used to ensure that the product(s) of the ATD provide a cost-effective, life-cycle solution that can be quickly transitioned into a formal acquisition program. All aspects of the life cycle need to be considered in order to optimize the end product. Early integration of IPPD tools, teams, and processes is essential to the efficient implementation of ATDs.

ACTDs are designed to respond quickly to an urgent military need. They employ available technologies, which frequently may have been successfully demonstrated in an ATD. Under ACTDs, systems are designed, fabricated, and then demonstrated in realistic combat exercises to gain an understanding of the military utility of the system, to support development of the associated concept of operations, and to place a limited but demonstrated capability into the hands of the warfighter at the conclusion of the ACTD. When additional quantities or capabilities are required to meet the full military requirement, the system enters the acquisition process at the point that is appropriate given the level of developmental maturity. Implementation of an IPPD approach is critical to the concurrent definition of user requirements, system design, and concept of operations.

Nondevelopmental Items

For programs considered to be Nondevelopmental Items (NDI), where little or no development is required, an IPPD approach still applies and should be employed in independent evaluation and planning activities which not only consider performance and delivery cost, but also fielding the system, to include training, maintenance, long term support, logistics, disposal, and follow-on products, as well as their associated costs.

OSD IPT Implementation

OSD implementation of IPPD has resulted in a major change in the way OSD maintains oversight and review of major programs. Guidance regarding the formation and use of oversight and review IPTs is contained in the DoD “Rules of the Road - A Guide for Leading Successful Integrated Product Teams” (see shaded area of figure 2-1). Guidance on IPTs for other than OSD oversight programs may be adapted from the “Rules of the Road”, this guide, or other government, industry, or commercial publications. Figure 2-1 depicts the types and focus of IPTs covered in “Rules of the Road” and in this guide.

Organization	Type	Inputs	Particular Responsibilities
OSD and Components	OIPT *	<ul style="list-style-type: none"> Strategic Guidance Tailoring Program Assessment Resolve Issues Elevated by WIPTs 	<ul style="list-style-type: none"> Program Success Functional Area Leadership Independent Assessment Issue Resolution
	WIPTs *	<ul style="list-style-type: none"> Planning for Program Success Opportunities for Acquisition Reform (e.g., innovation, streamlining) Identify/Resolve Program Issues Program Status 	<ul style="list-style-type: none"> Functional Knowledge & Experience Empowered Contribution Recommendations for Program Success Communicate Status & Unresolved Issues
Program Teams & System Contractors	Program IPTs **	<ul style="list-style-type: none"> Program Execution Identify & Implement Acquisition Reform 	<ul style="list-style-type: none"> Manage Complete Scope of Program, Resources & Risk Integrate Government & Contractor Efforts for Program Success Report Program Status & Issues

* See *The Rules of the Road, A Guide for Leading Successful IPTs*

** Covered by this guide

Figure 2-1. DoD IPT Types, Focus and Responsibilities

IPPD Tools

Implementing state-of-the-art methods and tools for planning, information, management, design, cost trade-off analysis, and modeling and simulation significantly improves the effectiveness of IPPD. It is incumbent on both DoD and its contractors to become knowledgeable of the capabilities of the tools, to integrate them into their internal tool sets, and to improve service to their customers.

Information technology and decision support

Document management, process documentation, and configuration control are important activities in traditional systems engineering and are even more critical in IPPD implementation. The concurrency of efforts, the numerous trade-offs being conducted, and successive prototypes under investigation make the documentation process an integral part of IPPD implementation. The architecture and process of the IPTs should be documented and retained. Directives, standards, specifications, team decisions and approvals, and policy and operating procedures are all reference data requiring categorization and control.

A common information system is needed to afford team members the opportunity to access program (product) or process information at any time and from any location. This access includes design information, automated tools, specifications and standards, schedule and cost data, documentation, process methodologies, program tracking, metrics, and others. If the IPT(s) members are not collocated, or if the teams are large, such a system may be a major undertaking in itself.

The number of tasks, the complexity of teams, and the early concurrency of interrelated activities, schedules and communications all require management via an integrated information system. This does not mean that a custom information system should be developed for each IPPD program; there are many commercially available off-the-shelf management information systems which can be integrated to serve this purpose. Commercially developed group decision support system software is also available for IPT use in conducting trade-off analyses.

In addition to complex shared databases, there are many commonly available communication tools that can be used to effectively facilitate information exchange and communication between team members. These tools include Fax machines, overnight mail delivery, increasingly effective teleconferencing, secure electronic mail, voice mail, Electronic Data Exchange (EDE), File Transfer Program (FTP), and video recorders. The last six tools are particularly useful because they are paperless.

Trade-off studies and prioritization

Cost, schedule, and system performance are the three classic parameters in all product and system acquisitions. Traditionally, analyses of variations in systems performance characteristics were conducted to obtain the resultant effect on projected system cost and development schedule. To take full advantage of the IPPD process, design trade-offs which evaluate system requirements versus costs must be conducted at an early design stage if we are to succeed in making cost an independent rather than dependent variable.

Performance parameters can be analyzed against design, testing, manufacturing, operations and support, training requirements, and overall life-cycle costs. The overall evaluation criteria should consider all aspects of the design including mission capability, operational safety, readiness, survivability, reliability, producibility, testability, manufacturing costs, and others.

Techniques such as Quality Function Deployment (QFD) can be useful in these complicated analyses. QFD is a systematic process for truly understanding the user's requirements and expectations and documenting the best approach and methods for satisfying these requirements.

The customer at times states requirements vaguely, and at other times too tightly, i.e., a specific solution. The QFD process revolves around understanding what the customer really expects and focuses efforts on satisfying these needs through extensive trade-off analyses. QFD also provides a way of tracking and tracing trade-offs through various levels from requirements through design decisions to production and support processes.

Cost-performance trade-offs

The Under Secretary of Defense (A&T) has directed that cost goals be used as a management tool. (USD(A&T) memo of July 19, 1995.) It is based on the concept of "cost as an independent variable," and has been initially adopted for ACAT ID/IAM ("ACAT IAM" refers to ACAT IA programs in which the Senior Information Management Official (the ASD(C3I)) is the MDA.) Although required in the memo for ACAT Is, it is encouraged for all programs. Life-cycle, cost-performance analyses conducted by integrated product teams are based on the principle that the best time to reduce life-cycle cost is early in the acquisition process, and that the best cost-performance trade-offs must be conducted before an acquisition approach is finalized.

Activity-Based Costing is a valuable tool for IPPD cost analysis. Activity-Based Costing focuses on the activities performed in the realization of a product. Costs are traced from activities to products, based on each product's consumption of such activities. The cost of a product equals the sum of all activities performed including overheads, capital costs, etc.

Traditional cost systems work well in processes where products are produced in large quantities by companies with a relatively simple cost accounting structure. However, batch sizes have become smaller, and competitiveness and budget constraints require stringent cost analysis. Traditional cost systems systematically "under cost" low-volume products, and "over cost" high-volume products. The objective of activity-based costing is to organize the actions into activities so that costs can be traced and estimated with a desired level of accuracy.

Design for manufacturing

Quality of the manufacturing process is most effectively attained if producibility is considered during design and development. It should be integrated throughout all elements and activities of a program. Product quality should be an integral part of design, production planning, and manufacturing efforts. The application of advanced design practices and tools to achieve product quality can be used in the Source Selection process as an indication of an effective IPPD process.

Many commercial manufacturers currently adhere to a collection of quality principles or imperatives known as Taguchi methods (proposed by Genichi Taguchi in the 1980s). Taguchi methods stem from the belief that quality is a virtue of design, and that the *robustness* of products is more a function of good design than of manufacturing quality control. Rather than process optimization, the target of this methodology is product robustness. The product is designed to accommodate a wider variation in the product processes without degradation of the overall product utility or value. Further, the quality of products or performance of processes must continuously be improved so that the deviation of product performance from specified values is minimized.

Prototyping

Prototypes can provide a representation of the product or system under development. Prototypes enhance communications between designers and users; they provide an opportunity for the user to better describe or gauge actual needs. In the implementation of IPPD, there is a greater need to develop prototypes on a rapid basis early in the design phase. Prototypes increase our knowledge about a product design and the associated manufacturing process in the product development life cycle and thereby reduce the time for completing the design and implementing production processes while reducing risk. However, prototyping must be controlled. Otherwise, unnecessary prototyping cycles can cause cost and schedule increases.

Virtual prototyping is a process for replacing physical prototypes by computational prototypes of products and processes. Its value lies in the potential for dramatically reducing product development time, manufacturing facility preparation time, and production cost while providing greater user satisfaction.

Modeling, Simulation, and CAE/CAD/CAM

Modeling and simulation technologies can be used as a cost-effective way to reduce time, resources, risks, and increase the quality of the systems being acquired. Representatives of proposed systems (virtual prototypes) can be embedded in realistic synthetic environments to support all phases of IPPD. Validated modeling and simulation should be applied, as appropriate, throughout the system life cycle in support of the various system acquisition activities, including (1) requirements definition, (2) program management, (3) design and engineering, (4) test and evaluation, (5) manufacturing, and (6) logistics support.

A product design that provides full customer satisfaction has to incorporate many features or requirements that consider not only the technical performance of the product but operational factors such as the skill required for use, reliability, supportability, even appearance. To provide expert knowledge in each of these factors, groups of specialty engineering -- commonly referred to as the "-ilities" -- are used to review the product design and they occasionally make suggestions to benefit their particular discipline. The experience of "-ilities" specialists has been captured into tools that fall into the general category of simulation-based design, e.g., Computer-Aided Engineering (CAE), Computer-Aided Design (CAD), or Computer-Aided Manufacturing (CAM)). Often it is still necessary to run these tools repetitively to achieve an optimum balance of all the desired product characterizations.

Metrics

Metrics, or measures of success, serve as a powerful management tool for evaluating effectiveness in accomplishing project objectives and in achieving and improving customer satisfaction. They allow Program Managers to manage on the basis of facts and data. The IPPD philosophy stresses defining processes and establishing check points to determine process health using accurate measurement and open, fear-free communication. Continuous measurable improvement should be an integral part of IPPD implementation. Defining and using process-focused metrics allows for early feedback and continuous monitoring and management of IPT activities and program maturation. Metrics solely focused on individual process results do not give a picture of overall success in implementation. Metrics, therefore, should also be structured to identify the overall effects of IPPD implementation. Measures that could be used to gauge

success include schedule, communications, responsiveness, and timeliness. Particularly useful is the measurement of variances between planned and actual schedules, consumption of resources, and completion of tasks. Also of great importance are measures of productivity, customer satisfaction, and cycle time.

Development Processes

Development Processes, as stated in Chapter 1, are activities which lead to the end product (which may itself be a process). DoD focuses on acquisition and contractor oversight processes and the linking of requirements with the Planning, Programming, and Budgeting System (PPBS). Industry, on the other hand, is primarily interested in processes which are a part of system development, contract and customer interface, finance and business, and DoD oversight. Some of these processes are shared interests between DoD and industry. Processes can be formally structured, such as the DoD acquisition process or the PPBS process, or informally structured such as a procedure created by an IPT to facilitate record keeping or maintain communication.

Development processes of interest to DoD are found at all levels of management. Generally, these processes fall into three categories:

- Policy processes are stated at the highest levels of the acquisition hierarchy. They involve such processes as the Requirements Generation System, PPBS, and the Defense Acquisition Management System.
- Oversight processes include those meant to verify program, contractor, or product performance. Examples are the test and evaluation process, risk assessments, earned value analysis, or contract audits.
- Management processes are generally those which are used at the Program Manager's level. These might include source selection, Request for Proposal (RFP) generation, design reviews, or archiving of documents.

Industry is the builder of a product or system and as such is interested in those processes which affect product cost, schedule, and performance and in DoD processes that interact with contractor processes. Product-related processes may include design, manufacturing, hardware and software research and development, or be financial in nature. Processes in which contractors interact with DoD may include the RFP, DoD audit, or contract arbitration.

Selected processes also generate information needed by a decision maker (e.g., risk assessments, developmental tests, analysis of alternatives) or may directly or indirectly impact cost, schedule, or performance of the product (e.g., operational test, design, manufacturing). It is important to understand the life-cycle processes of the system to ensure they are properly integrated into the system's life cycle and critical resources are properly expended.

Education and Training

A key factor contributing to IPPD success is education and training regarding IPPD management philosophy and the use of IPTs for the practical implementation of IPPD by the DoD staff. Program offices are encouraged to use their own facilitators or trainers as much as possible, and to enrich the training with as many examples, case studies, and lessons learned as are available. Each service and DoD should maintain a list of available educational resources for this program.

IPPD training may be viewed in three parts: program-specific, IPPD methodology, and team building. The program-specific training should assure that everyone has a common vision and understanding of the customer's requirements and the organization's purpose and products. Next is an overview of IPPD methodology and an introduction to the tools and techniques used to implement this management philosophy. Finally, team building exercises should be conducted to bring the organization together as a whole and to facilitate the cultural change. The organization's customers and suppliers should be included as an integral part of these activities.

In addition to the above, functional managers should ensure that representatives to IPTs are trained within their respective functional area. Training of functional representatives is necessary to ensure that the representatives stay current in their area and that they understand how their decisions within the IPT will be viewed by their managers.

Good training requires interaction between an individual with training and subject-matter expertise and a trainee with specific needs, understanding, and capabilities. Both, what is offered and what is heard are affected by the individuals involved. It is not possible for one trainee to bring the characteristics of an entire team into that interaction. Further, an individual cannot in one class take in all the knowledge presented. At best, only part of that knowledge is brought back. Nor is it possible to bring back to everyone all the skills and knowledge acquired by one individual. Therefore, a complete training process should include training in which individuals participate in teams.

What distinguishes IPPD training from education in general is not the underlying educational principles but the content and relationship to specific needs, i.e., the desired future state. The underlying principles and philosophy are the same. IPPD training efforts should strive to:

- Provide specific information on approaches needed for implementation (i.e. QFD, IPT, etc.),
- Improve problem-solving and leadership skills,
- Instill a team and a product/process orientation, and
- Develop risk assessment/intervention skills.

As with the use of IPPD, additional training should be offered that builds upon the initial three-part training. This training should provide detailed guidance on the implementation of the IPPD management philosophy as it pertains to a specific team. It should focus on the roles and interrelationships between the various disciplines and between teams, on the participation of core and adjunct members, and on bringing the group together as a team. The training should identify

customers, both internal and external, and the products delivered to those customers. This training should be repeated for any new team members and as a refresher for other team members as needed.

Barriers to Implementation

IPPD can provide tremendous leverage in managing product development. However, situations can develop throughout the process that can impede IPPD implementation or its effective use. Like most barriers of this nature, careful planning and vigilance can identify these problems and mitigate them as they arise. A description of some of the more common barriers follows.

Lack of sustained top management commitment

The first principle of successful IPPD implementation is to obtain unequivocal top management commitment. Without total top management commitment many employees may view IPPD as just another fad. *Recommendation: Obtain a written commitment from senior management to the principles of IPPD and its application to the program/product/service at issue before embarking on this effort.*

Cultural change required

Given current approaches, cultural change is required for the IPPD process to work. Because of the hierarchical structure of the military services, adaptation to the IPPD method of doing business may be difficult due to the changing roles of the different staffs. This perception can become more pronounced as differences in rank increase. It is essential that an atmosphere with freedom to express ideas without repercussion from those conflicting views is created. *Recommendation: Do not underestimate the forces of resistance to change. Spend what may seem like an inordinate effort on cultural change management. To the maximum extent possible, utilize a rewards system to recognize and encourage the desired change.*

Functional organization not fully integrated into the IPPD process

Functional organizations are responsible for technology development, personnel development, process improvement, and administrative functions. These activities cannot be adequately performed if the functional organization and its people are treated as outsiders to the work to be accomplished. For example, process improvement can only occur when teams understand and use the processes developed by the functional organizations. *Recommendation: With the implementation of IPPD, the role of the functional organization changes from controlling the work of the program to the care and development of the resources available to the team. These include people, information systems, libraries, models, education and training, public and financial recognition, and often operational processes and capital equipment.*

Lack of planning

Planning can be rushed and incomplete as teams quickly form to start an effort already behind schedule. *Recommendations: (1) Up-front planning that includes all functions, customers, and suppliers must be accomplished at the start of any team activity. This allows the program activities and work to be defined and the early identification and management of risk. (2) The integrated master plan must be consistent with the project/organization objectives and it must be*

constantly reevaluated and modified to meet current team needs and capabilities. (3) Resist temptation to take short cuts - it will cost more later.

Insufficient education/training

Education/training has often been overlooked in the process. Sometimes it is assumed that members have received the required training and, therefore, do not require additional education/training. *Recommendation: Include IPPD education/training as an integral part of the comprehensive up-front planning. In order to optimize the effect of training, it should be done immediately before the particular skill is required.*

Lessons learned and good practices not shared across programs

There is often a lack of communication across programs/organizations in areas of problem solving, lessons learned, and good practices. *Recommendation: A formalized, documented process for exchanging information related to IPPD implementation should be created and used.*

Not invented here

There is a natural tendency when things are not going well for a team to focus on its immediate problems to the exclusion of other organizations and their needs. A "Not Invented Here" philosophy can develop causing teams to exclude ideas/inputs from their internal and external customers and co-workers. *Recommendation: The key concept that must be stressed is the idea of teamwork — all individuals working together for a common goal. Publicly acknowledge when good ideas are brought in from outside the team.*

IPPD practices directed by contract

A series of "approved, recommended, or best practices" for applying IPPD should not be contractually imposed. These practices will become standards by implication and contractors will be hesitant to deviate from them for fear of being found non-responsive. *Recommendation: The contractor selected should already have established an IPPD culture and should not need steps for implementation dictated by DoD. If presently imposed in existing contracts, seek to remove them if feasible.*

Contractor uses IPPD/DoD doesn't

Problems may arise when DoD expects contractors to use IPPD approaches, but DoD does not participate in IPPD tools, teams, or processes. *Recommendation: DoD must suppress the tendency to monitor progress along functional lines, to conduct design reviews function by function, and to mandate accounting methods that inhibit IPPD.*

DoD asks for IPPD in RFP but awards to traditional approach bidders

It will not take long for contractors to pick up on the fact that DoD may ask for new and innovative IPPD approaches in the RFP, but still awards contracts based on lowest cost and traditional approaches. *Recommendation: If the IPPD approach is to work, DoD's commitment must be real.*

Contractors promise more than they can deliver in implementing IPPD

The possibility of contractors promising more than they can deliver has always been a problem for Source Selection Evaluation Boards (SSEBs). This will be an even greater concern in an IPPD

environment because, in the spirit of teamwork, oversight may develop a tendency to be less independent than prior to IPPD implementation. A related trap is if contractors parrot back the IPPD requirements without making the internal cultural changes needed to operate using IPPD techniques. *Recommendation: It is important that the SSEB become familiar with successful IPPD techniques/methods and what can realistically be done, perform a thorough technical evaluation of each proposal, and look closely at contractor past performance in IPPD implementation.*

Poor incentives/award fees criteria

Under the IPPD philosophy, the driving force behind incentive/award fees should be successful product/process development. Concurrent product and process development, full life cycle design considerations, and continuous improvements should be the focuses. Unfortunately, some contract incentive criteria can disincentivize contractors from using IPPD. For example, incentivizing only development cost can cause the contractor not to perform needed design analysis, testing, and alternative examination. Incentivizing meeting of scheduled milestone events, such as design reviews, causes contractors to meet those dates whether they are ready or not. *Recommendation: Better contract incentives can be based on effectiveness of the contractor's IPPD methods and measures of contractor performance in meeting or exceeding contractual requirements. Beware of including criteria which may preclude optimization of the product.*

Over-extended reviews

When all members of a multifunctional team are encouraged to participate in a design, many questions and issues will be brought up which could be discussed for an excessive time. *Recommendation: Setting a specific agenda for meetings and reviews should create a structure that allows for the discussion of issues. This structured agenda should not allow the discussion to be dominated by any one specific point. Time limits, however, should only be stressed by the meeting facilitator or chairperson when the discussion becomes repetitive, or a consensus cannot be reached.*

References:

Clausing, Donald. "Robust Quality." Harvard Business Review. Jan.-Feb. 1990:65-75.

National Council on Systems Engineering. "Systems Engineering Benchmarking Report." November 1994.

Office of the Assistant Secretary of Defense (Economic Security). Concurrent Engineering/Integrated Product Development Handbook to Understanding and Implementation. 23 June 1993.

Principle Deputy, Under Secretary of Defense for Acquisition and Technology. Memorandum. 26 May 1995.

Taguchi, Genichi. System of Experimental Design. Dearborn, Mich.: UNIPUB/Kraus International Publications, 1987.

Under Secretary of Defense for Acquisition and Technology. Memorandum. 19 July 1995.

Under Secretary of Defense for Acquisition and Technology. Memorandum. 14 Aug. 1995

Other Recommended Reading:

GM Hughes Electronics. "CMI Tools, Continuous Measurable Improvement Tools and Methodologies." GMHE IRC Publication.

Hughes Aircraft Company. "CE/IPD Program Event Matrix Guideline." Hughes Space and Communications, 1993.

HQ AFMC/ENS. "Integrated Product Development and Supporting Initiatives." 20 July 1992.

OUSD(Acquisition & Technology)/Acquisition Program Integration. "Rules of the Road — A Guide for Leading Successful Integrated Product Teams." November 1995.

Shonk, James H.. Team-Based Organizations, Developing a Successful Team Environment. Homewood, Illinois. 1992.

Winner, Robert I., James P. Pennell, Harold E. Bertrand, and Marko M. G. Slusarczyk. "The Role of Concurrent Engineering in Weapon System Acquisition." Institute for Defense Analyses Report R-338. Virginia. December 1988.

Chapter 3 Management of IPPD in DoD Acquisitions

“Cultural change cannot be directed from the top. We need buy-in at the working level as well. I hope you will join me...by working together to improve our product --- fielded equipment that works within a shortened acquisition cycle time.”

Paul G. Kaminski, 3 October 1995

Background

The two previous chapters have described IPPD concepts, tools, processes, and barriers to implementation. This chapter explains the roles of DoD and industry in the IPPD process and the industry-DoD team relationship.

Industry and DoD use IPPD to work as a team. Each performs a different function. Industry is the developer of the product and contributes state-of-the-art technical expertise and best manufacturing practices to the team. DoD manages the effort and contributes by removing impediments which hinder success of the program.

DoD's Role

DoD acts in the role of the customer or user by defining the need for and evaluating performance of a product or process. The DoD also performs the role of the acquisition manager, validating the need, researching alternatives, defining requirements, allocating resources, determining priorities, measuring technical and operational performance, and establishing an operational and support capability.

As a manager, DoD balances three systems (Requirements Generation System, Acquisition Process, PPBS) to acquire affordable products which meet the users' needs. This role requires decisions based on cost, schedule, and performance trade-offs, risk analysis and management. Because of the need to do more with limited funding, it is important that DoD requirements and acquisition personnel understand the IPPD tools, teams, and processes used by industry, as well as DoD.

As the ultimate and often only customer, DoD defines operational performance requirements for the needed system. In the customer role, DoD conveys information to both industry and DoD acquisition management through many fora.

Acquisition managers, using the IPPD process, establish an oversight and program IPT structure that meets their needs for managing their programs. Guidance on how OSD oversight and review IPTs are implemented for ACAT ID/IAM programs may be found in the DoD "Rules of the Road" publication. A notional program IPT structure for program implementation is shown

in figure 3-1. This structure will vary from program to program depending on scope and complexity.

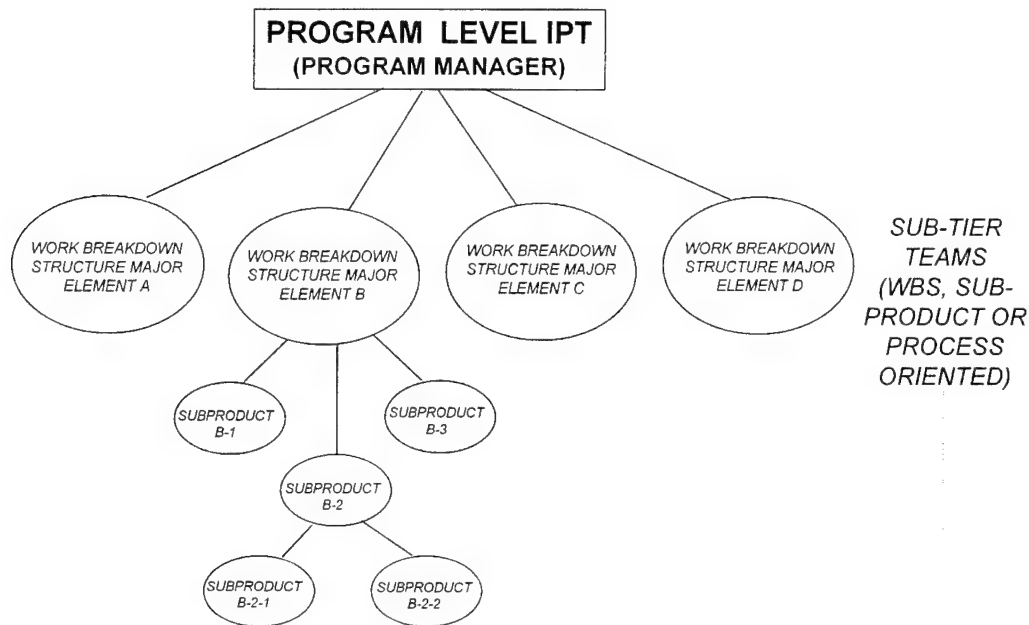


Figure 3-1. Notional IPT Structure

A Program level IPT is formed to provide for program execution. This IPT represents the system level in a structure where multiple levels of IPTs may be required due to program size or product complexity. Usually, the leader is the Program Manager. Selection of team members is an important part of the process. Normally sub-tier team leaders are members of the Program IPT and provide for integration. Careful consideration needs to be given to the multidisciplinary requirements of the team during selection.

Sub-tier Teams implement plans for product development created from the acquisition strategy. These IPTs manage elements of the program's resources and risk, integrate government and contractor efforts, and report program status and issues. These teams are created as necessary to execute and track program plans, usually in concert with the Work Breakdown Structure (WBS), and also may be formed functionally, or process related (i.e., support, manufacturing, etc.). Sub-tier Teams may consist of functional representatives from DoD, the Services and industry. Teams may be created in a horizontal or vertical relationship with other teams at the discretion of the Program Manager.

This notional structure allows for the creation of an integrated management framework employing resources (tools, teams, processes) as part of a disciplined approach (see Chapter 1). An integrated management plan can then outline actions by which the product is acquired.

Users, program managers, functional managers and acquisition management staff should be represented in IPTs along with contractors and suppliers. To achieve the full potential of IPPD, team members must be empowered and capable of effectively performing their IPT roles. Representative tasks and responsibilities include:

Program Managers are responsible for managing the program as a whole. Tasks, as cited in industry literature and survey responses, include ensuring that:

- Funding profiles and program schedules are adequate to support early involvement of all functional elements that have a stake in the design concept.
- Teams as a whole - not just the team leaders - are held accountable for team performance.
- Team members work to optimize the entire program - not just their functional discipline.
- Product developments and downstream process decisions are made within the team bounds and not by either functional or program management.
- An environment exists to support cohesiveness within and among IPTs.

The program manager, and possibly his staff, will normally be involved in both the oversight and review IPTs as well as the execution, or program level IPTs.

Functional Managers are responsible for guiding and ensuring consistent practices for their functions across IPTs. Tasks, as cited in industry literature and survey responses, may include ensuring:

- Long-term interest in the education, training, career development and assessment of employees assigned to teams is maintained.
- Continued maintenance and development of centers of functional excellence.
- Technical expertise and perspective are provided.
- That Functional Managers understand the programs that their staffs are supporting so that they can better manage their own technology development.

Acquisition management staff support is required from many DoD functions and activities not directly engaged in the technical aspects of product and process design. Specifically:

- The user community's single most valuable contribution to a successful IPPD effort and program is at the very outset to provide guidance for a realistic, stable statement of mission needs. Stability is important. To achieve stability, fewer revolutionary advances may be indicated and a shorter schedule assumed. A cause for requirements instability and delays results from waiting for significant technology advances. The user community should participate in and be open to cost/performance trade-offs.

- A well-constructed RFP and a sound acquisition strategy are important keys to successful acquisition. The RFP should be structured to assure that language does not create barriers to implementing IPPD and should incentivize the use of IPPD.
- Cost accounting organizations can provide useful cost information necessary to make cost/performance trade-offs. Methods must track changes in process management due to IPPD, improved information technology, and other process improvements. Traditional cost prediction is based only on past history over long periods.
- The comptroller should recognize that a need may exist to incur higher development costs at an earlier point in the life cycle than is the case in traditional acquisition programs, and to support that requirement.
- The legal staff may play a role in areas such as patents or product liability of commercial products used in the system under acquisition, data rights, and the role of DoD and industry personnel in IPTs.
- DoD/Service schools should provide the necessary training and education outlined herein to assure DoD staff understanding of the IPPD process and their respective roles in successful IPPD operations.

Industry-DoD Team Relationship

A positive early relationship between DoD and industry can be key to effective management. Early planning, a key tenet in IPPD management, should involve the customer and supplier. Part of that tenet is to involve the customer and supplier as soon as possible, especially in the requirements definition phase. In some cases, it may be beneficial to involve many suppliers with the greatest potential to assist with requirements definition. This can be done through a variety of methods.

Request for Information (RFI) process where the goal of DoD is to gather information on technology and systems development to aid in refining the initial requirement. Industry provides this information to assist DoD in writing a Request for Proposal (RFP) that can be responded to by industry.

Electronic bulletin boards perform multiple roles in DoD/industry communications. Bulletin boards post relevant information and ask questions anonymously for viewing. This type board provides for sharing of information without revealing source or competitive strategy.

Libraries for industry can be established to provide a repository of DoD literature regarding the acquisition process and requirements, acquisition, and budgetary documentation.

Vendor conferences provide a forum for sharing information by way of briefings and question and answer sessions between industry and DoD. They also update all parties on the status of the requirement.

Draft RFPs allow prospective bidders to comment on RFP content, particularly Statements of Work (SOW). An advantage of this approach is for industry to address RFP contents which require explanation or may unnecessarily restrict concept development or exploration of novel approaches. This effort should result in a better final RFP.

Once sufficient information has been gathered, the program concept can be defined using a systems engineering approach similar to that outlined in Chapter 1. This can be done with the assistance of a SETA contractor who is knowledgeable in the technical area being explored. This contractor is to act as an independent technical advisor to DoD and is particularly useful when DoD has a need to augment its technical expertise.

The IPPD approach facilitates the effective use of tools that can be used in the development of an RFP. To realize the advantages of IPPD, team members who participate in WBS, SOW, and RFP development should be retained and utilized throughout the execution of the resulting contract. Members of teams that develop the WBS, SOW, and RFP, potentially form the best source selection team.

“I want all those involved in the acquisition process to employ these concepts for all acquisitions when it makes sense. The Department’s oversight staffs shall fundamentally shift their roles from sequentially checking on a program beginning six months prior to a milestone decision point to participating early to facilitate program success through continuous teamwork and assistance throughout the acquisition process.”

William J. Perry, 10 May 1995

References:

U.S. Air Force. Air Force Material Command Guide on Integrated Product Development. Air Force Material Command, 25 May 1993.

U.S. Air Force. Integrated Product Development Implementation Guide. Space and Missile Systems Center, March 1993.

U.S. Army Materiel Command. Integrated Product and Process Management. 25 May 1995.

Other Recommended Reading:

HQ AFMC/ENS. "Integrated Product Development and Supporting Initiatives." 20 July 1992.

Appendix 1

Acronyms

ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
ATD	Advanced Technology Demonstration
ADM	Acquisition Decision Memorandum
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CAM	Computer-Aided Manufacturing
CTP	Critical Technical Parameters
DAB	Defense Acquisition Board
DoD	Department of Defense
DoDI	Department of Defense Instruction
DOT&E	Director, Operational Test and Evaluation
DTC	Design to Cost
DTSE&E	Director, Test, Systems Engineering and Evaluation
ECP	Engineering Change Proposal
EMD	Engineering Manufacturing Development
ILS	Integrated Logistics Support
IMP	Integrated Master Plan
IMS	Integrated Master Schedule
IPPD	Integrated Product and Process Development
IPS	Integrated Program Summary
IPT	Integrated Product Team
JROC	Joint Requirements Oversight Council
LRIP	Low-Rate Initial Production
MDA	Milestone Decision Authority
MNS	Mission Need Statement
MOU	Memorandum of Understanding
NDI	Non Developmental Item
OIPT	Overarching Integrated Product Team
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
PPBS	Planning, Programming, and Budgeting System
QFD	Quality Function Deployment
RFI	Request for Information
RFP	Request for Proposals
SETA	Systems Engineering and Technical Agent
SOW	Statement of Work
SSEB	Source Selection Evaluation Board
SSP	Source Selection Plan
TEMP	Test and Evaluation Master Plan
TPM	Technical Performance Measures
USD(A&T)	Under Secretary of Defense for Acquisition and Technology
WBS	Work Breakdown Structure